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THE PRESENT STATUS OF ANTHROPOLOGY[1]

By Professor RALPH LINTON
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THE anthropologist modestly delimits his field as the study of man and his works; the most ambitious claim ever staked by any scientific investigator. Under such a definition there is no branch of human knowledge or activity which does not fall within the scope of his interest. Even astronomy or atomic physics can be included on the basis that, although the phenomena with which they deal are extra-human, the technique for investigating these phenomena and all knowledge which has been acquired regarding them are parts of man's culture. However, there is a wide divergence between the high hopes embodied in the anthropologist's delimitation of his subject-matter and the actual content of the science as it exists to-day. Anthropology was one of the last sciences to take form, and by the time it appeared it found the center of its hypothetical field already occupied by a series of other disciplines with well-developed techniques and extensive bodies of knowledge and theory. Whatever its ambitions, anthropology was compelled to find a place for itself in those areas which had not already been preempted. It became a sort of peripheral science working in the corners and interstices not covered by the older disciplines. Thus in the study of physical man it found itself confronted by the vested interests of anatomy, physiology and more recently genetics and turned its attention to the study of human variations and the classification of human types. In the study of individual behavior it has encountered the vested interest of psychology, while in the study of group behavior it has been confronted by history, sociology and economics. Its response to the challenge of the last three has been characteristic of its whole course of development. With history it evaded the issue by turning its attention to the great stretch of

[1] Address of the retiring vice-president and chairman of the Section on Anthropology, Indianapolis, December 30, 1937.

human existence which lay before the development of written records. With sociology and economics it compounded by ignoring the Western European culture which they had taken as their frame of reference and devoting itself to the analysis of the same orders of phenomena when they occurred in so-called primitive cultures. As a result of such hedging, anthropology as it exists to-day is not a well-rounded, systematically organized science but a series of discrete and limited fields of investigation which, although they all relate to man, are related to each other mainly through the media of other disciplines whose content is rather imperfectly known to the average anthropologist. For this reason it is extremely difficult to survey the present status of anthropology as a whole. The problem can be approached only through an evaluation of the advances which have been made by each of its several parts.

Within the body of the science itself the broadest hiatus lies between the divisions of physical and of cultural anthropology. Each of these is, in both its interests and its techniques, more closely related to certain other sciences than to its anthropological bedfellow. The study of man's origins and varieties is a branch of the natural sciences, and any attempt to isolate it from them merely results in cutting off the worker in this field from a rapidly developing body of new knowledge and techniques. I hasten to add that in one of its aspects, the study of human origins, such isolation has never occurred. Here the findings of paleontologists and of workers in the field of evolution have found ready acceptance. As a result this branch of anthropology has progressed and is progressing rapidly. Man's position as a primate and a derivative of some sub-human form has been established beyond question, and it remains only for the paleontologist to bring to light the fossils which will establish the exact line of human descent. In spite of a few dissenting opinions it appears fairly certain that the Hominoid stem began to separate from the other primate lines by at least the close of the Miocene, that in the course of its evolution it produced numerous genera and species and that none of the fossils so far brought to light are in the direct line of ancestry of modern man. No field of anthropological research is more live at the present time, and new discoveries necessitate the almost yearly revision of books on the subject. It seems probable that the main problems will be solved within another ten or fifteen years.

The study of human varieties, that is, of race, has not been equally successful in keeping pace with the developments in related sciences. This is the oldest branch of anthropological study, a direct outgrowth of the systematic, classificatory activities of the eighteenth century naturalists. By the time that the principles of evolution achieved recognition, racial studies had already accumulated a mass of data and with this certain dogmas. The most important of these was that the various human varieties were static entities, subject to modification only through the agency of race mixture. This dogma persisted and in fact still persists in certain quarters in spite of a recognition of the evolution of our species as a whole from some lower form and of the mutability of other species. Such inconsistency can be explained in part by the historical situation. Europeans have established themselves as rulers over many groups whose physical type is markedly different from their own, and race has become a simple and obvious indication of social status. Moreover, the dominant European has been quick to seek in such racial differences the justification for rule and exploitation which he can no longer derive from religious sanctions. To question the existence of primary racial divisions of mankind with differences in evolutionary status and innate abilities is to question one of the most elaborate rationalizations of the *status quo*. Until comparatively recent times most physical anthropologists have been willing to accept the doctrine of the fixity of human varieties and to devote their time and energy to more and more minute differentiation of these varieties, increasingly elaborate racial classifications and speculations as to racial movements. Unfortunately, or perhaps fortunately, most of these speculations will never be susceptible of proof or disproof, since most of the characteristics which racial classifications are based are of a superficial and not ascertainable from skeletal remains. Even the most extreme advocates of racial fixity must admit that there is a whole series of European Neolithic and Bronze Age remains whose ascription to either the glorious Nordics or the despised Mediterraneans depends mainly on the special interests of the observer.

Although old style racial studies have received a powerful impetus in at least one European country, many of the younger physical anthropologists are beginning to recognize this approach as a cul de sac and to turn elsewhere. A new concept of race is appearing; one that treats human varieties as dynamic rather than static phenomena. It has already been proved that the physical type of an approximately pure racial group may change when that group moves into a new environment. Why such changes occur is still unknown, as are the limitations which may be imposed upon such changes by the heredity of various racial groups. When these problems have been solved, investigators can turn again to the old questions of classification and relationships with a new and sounder approach.

Hand in hand with this change in the attitude toward race there has gone an extension of the study of racial

differences. The anthropologist is no longer content with superficial measurements but investigates blood types and is beginning to be conscious of differences in such things as growth rates, metabolism, hormone balance and specific disease resistance. In following all these new leads physical anthropology must lean heavily on the results and techniques of related sciences, but it seems that its contribution to them may, in the long run, prove quite as important as their immediate contributions to it. Thanks to such cross-fertilization a discipline which was becoming moribund is taking on a new lease of life. Where the physical anthropologist of twenty years ago must have felt that the main problems of his science had been solved the one of to-day realizes that many of these problems have barely been perceived.

This current tendency to bring physical anthropology into closer liaison with a whole series of natural sciences may widen still further the gap between it and cultural anthropology. The connection is already so tenuous that a complete break between the two seems well within the bounds of possibility. The phenomena with which the two disciplines deal are of different orders and the question is whether there is any real link between these orders. In the early days of anthropology the existence of an integral relationship between race and culture was taken for granted. It is obvious that every culture is always associated with a particular society. Morever, most societies, [redacted]hose at the so-called primitive level, are [redacted]ups with their own characteristic norms of physical type. The assumption that the particular qualities of various cultures were in some way correlated with the distinctive physical qualities of their bearers was therefore a natural one. It was the cultural anthropologists who first brought the real nature of this observed correlation of culture and physical type into question. They were able to show that culture elements have been transferred repeatedly from one racial group to another without any important changes in form. They also showed that individuals have frequently assumed the culture of the society in which they were reared when they were of different racial affiliations. The fact that some individuals seem to have a good deal of difficulty in doing so or accept the alien culture only in part was explained as due to a late commencement of the conditioning process or to the social disabilities from which an individual of markedly different physical type suffers in most societies.

At present, one group of anthropologists, mainly European, are still strong proponents of an interrelation between race and culture, while another and equally dogmatic group claim that all the existing correlations are purely fortuitous and explainable on historic grounds. Actually, it would seem that the question is still an open one and offers a promising field for further research. The first step in such an investigation will have to be a clearer definition of the term race. If this is taken to mean one of the great divisions of mankind, as Negro or Caucasian, it seems unlikely that the members of any one of these divisions, taken as a whole, differ from the members of any other division in ways that might have a significant influence on culture. The various human breeds which have been assigned to each of these great divisions differ too much among themselves. However, if we apply the term race to small inbred groups all of whose members have a common recent heredity, it seems that there may very well be differences which would be of significance. Without attempting to go into the complicated problem of nature versus nurture, there seems to be steadily accumulating evidence that intelligence and those elements within the personality which are responsible for what we rather vaguely call temperament have some physiological foundation. If so, the majority of the members of any inbred group might well have inherited characteristics which would make certain patterns of behavior congenial to them and others uncongenial. Such factors might be of considerable importance in determining both the direction of internal development in the group's culture and the group's reaction to new elements of culture made available to them by the processes of diffusion. It seems unlikely that even if the cultural and physical anthropologist work together they will be able to solve this problem without assistance from such outside sciences as physiology, genetics and especially psychology.

The main contributions of physical anthropology to date have been to establish man firmly in his place among the other mammals, indicate the probable line of his evolution, and, through classification, to bring some order into the confused field of his variations. These are worthy accomplishments, but much more remains to be done than has been done. Let us turn now to the field of cultural anthropology.

Cultural anthropology falls at once into two great divisions; archeology, which is the study of past cultures or phases of culture, and ethnology, which is the study of living cultures. These two are bound together by a common interest in culture origins and the processes of culture change. In those parts of the world for which written records are available the zones with which these two disciplines deal are separated by short sections of the culture continuum whose study has been preempted by the historian. However, in most cases this section is so short and the material with which the historian deals so little germane to the anthropologist's problems that ethnology and archeology

have to join hands over his head. From the very inception of writing monuments and inscriptions have been designed mainly for propaganda purposes and scribes have written largely for the glory of their employers. Even in well-documented cultures such as those of Greece or Rome innumerable details of daily life and changing custom can only be established by excavation. Note the contributions to knowledge which have come from the digging up of Pompeii and Herculaneum. In many parts of the world, North America, for example, the field of archeology passes into that of ethnology practically without a hiatus.

In spite of this there has been a regrettable tendency, especially in North America, to try to keep the archeological and ethnological disciplines distinct. Historically the reason for this may be traceable to the white pioneers' underestimation of the Indian's cultural accomplishment and the early development of the romantic Mound Builder myth. Actually, the lack of cooperation between the two disciplines has done much to retard the development of both. Again and again the ethnologist can offer data which will help the archeologist to understand his findings. Thus the ethnologist's record of historic Indian mortuary practices has removed the battle and pestilence explanations once invoked to explain the phenomena of mass burial. Again, the recently discovered culture pattern of the honored child, wide-spread in the Plains during the historic period, suggests a new explanation for certain child burials which have puzzled archeologists for generations. The erection of a mound over a single infant or the placing of rich offerings with small children, often taken as an indication of human sacrifice, now becomes comprehensible. Conversely, the ethnologist can only verify legends of tribal movements from the archeologist's findings. The recent tendency to work in historic or proto-historic sites, thus connecting archeologically known cultures with ethnologically known ones, is a long step toward the necessary synthesis of the two approaches.

If we turn to a survey of the present status of these two branches of cultural anthropology we must admit at the outset that archeology can show the larger record of accomplishment. Against this must be set the greater clarity of its aims and the more obvious nature of the techniques to which it owes its advance. The archeologist is seeking specifically to recover the past of culture while the ravages of time have limited the materials with which he can work to a small sector of culture as a whole. Although he may obtain hints of the beliefs and practices of ancient peoples, his main concern must be with their technology. These limitations give him a frame of reference at the very outset, and each new find helps to delimit his problems more clearly. His task is much like the reconstruction of a three-dimensional puzzle of many pieces. Each new object and each established time horizon suggests where the pieces already in hand should go. A single new item of knowledge may bring into order a whole series of previously disassociated facts. This search for culture origins has much in common with the search for human origins. In both there is a relentless narrowing of the field for speculation as the facts come in. The most elaborate theoretical structure can be demolished over night by a fossil from a particular geological period or the presence of a certain implement type between such and such levels in a cave deposit. Moreover, the evidence in both cases is concrete and tangible, something that can be worked over with the aid of the techniques which have already proved their worth in the natural and physical sciences. The wise archeologist must keep close to the ground, a fact which makes the ethnologist regard him with either envy or contempt, depending on the personality involved.

The accomplishments of archeology to date are far too numerous to be listed here and are, in any case, familiar to most anthropologists and to a large and ever-increasing section of the reading public. Every new find tends to be well, if often not too wisely, publicized. We will not trouble, therefore, with the resurrection of specific cultures, dealing only with discoveries of wide implication. First of all, the beginnings of culture have been pushed back to a [redacted] so remote that it appears highly probable that [redacted] of tools and fire, once considered an exclusive [redacted] trait, was actually shared by several species and perhaps even genera of highly evolved primates. Second, it has become possible to differentiate a number of distinct streams of evolving culture and to trace their development and interrelations. Lastly, much light has been thrown on the process of culture evolution itself. It has become plain that all cultures have not adhered to the same evolutionary sequences. Thus the order of technological advance from stone through copper and bronze to iron, once taken to be universal, is now recognized as a characteristic of only certain lines of evolution. There are numerous areas in which the transition from stone to iron was direct. Much light has also been thrown upon rates of culture evolution. The old theory of a steady, progressive acceleration of cultural development from the earliest period to the present can no longer be accepted. In at least some culture streams periods of amazingly rapid growth seem to have alternated with long periods of comparative quiescence. Thus the history of our own Southwestern culture, as revealed by tree ring dating, shows a flare-up which carried it from a relatively simple condition to a complexity as great as that of the historic period in an interval of about three hun-

dred years. Again, finds in the Near East seem to indicate that the domestication of plants and animals in that region was followed by an extraordinary flowering of culture. During the first thousand years of food-raising there were such basic advances as the development of metal working, writing, the wheel, the plow and the loom and a host of minor items. Although later times produced a long series of minor improvements and all sorts of changes were rung on the original themes, there was no comparable period of rapid development until the recent rise of scientific techniques. We must now picture the evolution of culture as a process in which sudden mutations have paid quite as large a part as slow, continuous changes.

This irregular rate of culture advance makes the development of more exact techniques for dating finds a matter of pressing importance. Two levels in the same culture continuum which show marked differences in content may be separated in time by only centuries instead of millennia. Tree ring dating marks a great advance, but it has numerous limitations. It depends upon the preservation of wood and on the establishment of a continuous series running back from some known date. Moreover, there is no proof as yet that it can be trusted in regions where there are no marked fluctuations in rainfall. Even under optimum conditions it can help us with only a short upper bracket of culture history. At the lower end of the American archeologist's time-scale the geologist's work with glacial varves has already proved its value, but the dating methods of the geologist are better suited to his work than to ours. A thousand years means little in the earth's history, but a century may be crucial in the development of a culture. Our dating problem is still unsolved, and if it is solved we may be sure that the technique will come from some other science, as tree ring dating has.

Hardly less pressing than the need for better dating is the need for more objective and exact methods in the study of specimens for the establishment of relationships. Here certain lines of approach are obvious and progress is already being made. Pottery is being attacked by microscopic techniques and experimental methods, and although the study is still in its infancy there have been some rather surprising results. Thus the discovery that Yucatan pottery is tempered with volcanic tufa, although no deposits of this material exist on the peninsula, raises some interesting problems. Again, the discovery through firing experiments that most of the clays from which Woodland wares are made require no tempering, although such wares are uniformly tempered, reinforces the theory that pottery making was introduced into this region as a developed technique. Microscopic studies of aboriginal copper implements from the Great Lakes region prove that their makers employed the annealing process, showing a hitherto unsuspected skill in metallurgy and suggesting cultural connections with the more advanced groups to the south. It is evident that there is a rich field here which has barely been scratched.

Lastly, a point which I mention with some hesitation in this company, there is a real need for more and better trained amateur archeologists. There is a widespread feeling among professionals that an amateur is merely some one who gets to a good site before you do and spoils it. Unfortunately this has frequently been the case, but it need not be so. There can be no truce between the scientist and the pot hunter, but the serious local amateur can make important contributions to knowledge. He can learn sound scientific techniques, which after all are not particularly esoteric, and is usually eager to do so if the professional will give him a little encouragement. He is in a position to learn all about a certain limited territory and, above all, he is on the spot to take care of accidental finds which may prove of the greatest value. The earliest cultures on this continent were so simple and the populations which carried them so sparse that the discovery of their remains must always be largely a matter of chance. If really ancient man is ever found in America the chances are ten to one that the find will be made by some non-professional who is watching work at a gravel pit or road excavation.

When we turn from archeology to ethnology we find that an enormous amount of descriptive factual material has already been accumulated and that techniques for observing and recording cultural phenomena have undergone a steady improvement. Ethnology began with travelers' tales about the curious customs of alien peoples, just as archeology began with the antiquarians' search for art objects. To-day both sciences have come to realize the importance of the usual and commonplace. It is now the avowed intention of the ethnologist to record cultures as wholes, although he always falls short of this in practice. The practical difficulties of producing a complete factual account of the content of any culture and the complex interrelations of its elements are nearly insurmountable. The study itself would require several years, while the final report would be of such vast dimensions and of such deadly dullness throughout much of its length that the publication would be impossible without heavy subsidies. What actually happens is that the observer, consciously or unconsciously, selects certain aspects of the total culture for intensive description and deals with the rest in summary fashion. This is a great improvement over the picking up of scattered curios, but it leads to much recrimination between ethnologists. Every report is silent upon some point or other which some particular

worker or school of workers considers of paramount importance. Thus the members of the recently emerged functional school have been particularly vociferous about the shortcomings of the current ethnological literature, yet their own reports are equally disappointing to students interested in trait distribution or technology or the dynamics of culture change. These lacks are the more striking, since this school is particularly insistent on the necessity of studying and recording cultures as integrated wholes.

In spite of these shortcomings, the main difficulty of ethnology to-day lies not in a lack of data but in its uncertainty as to what to do with the material already in hand. The science has plenty of limited objectives, but is weak in its conceptual framework and vague as to its ultimate aims. Proof of this is afforded by the existence of a whole series of schools of ethnology each of which is pursuing its own special line of attack on culture problems with indifference or even active hostility to the work of the rest. The same condition has marked the youth of all sciences, and all of them have followed much the same course. As soon as a science becomes sure of its aims and the limitations inherent in its materials, its conflicting schools dissolve, leaving a residue of particular techniques for attacking particular problems. Unless this sort of synthesis begins soon, we will have to regard ethnology as in a state of arrested development.

If ethnology is to be rated as a descriptive science, it can show a good record of accomplishment. If it wishes to be rated as a dynamic science, its work has barely begun. The ultimate aim of all dynamic sciences is to give man the power to control or at least predict the phenomena with which they deal, and an intensive study of process is the first step toward this. The first systematic approach to the study of culture, that of the evolutionists, was based on the assumption of a definite, uniform sequence of stages in culture development, a particular process of culture growth. The recognition that this assumption did not check with the facts led to a study of growth processes as they occurred, and from this study there emerged the general principle of diffusion. That this principle, once recognized, was turned to the often questionable uses of historic reconstruction does not diminish its validity. It is a current fashion to underrate the importance of the discovery of diffusion and to deprecate the work of those who have investigated it intensively, yet it was the first step toward a real understanding not only of culture processes but of the nature of culture. The fact that single culture elements or complexes of interrelated elements can be transferred from one culture continuum to another simply by contact has tremendous implications. It introduces an irreducible element of chance into the processes of culture growth, making accidents of contact as important as internal factors in determining the content of a culture continuum at any given point in its length. It means that a given society may step from a hunting economy to an agricultural one, or from the use of stone to highly developed iron working, in a single generation. The general principles of culture evolution thus lose most of their validity when applied to specific cultures. Furthermore, the ability of cultures to accept and assimilate elements of foreign origin indicates that the organization of cultures must be of a singularly loose and flexible sort. If the integration of cultures was a matter of rigid, exact adjustments, new elements could not be fitted in or old elements discarded with such ease. The fact of diffusion thus disposes once for all of the possibility of understanding culture phenomena by reasoning from biological analogies. It proves that these phenomena are of a different order from those exhibited by even the most complex forms of life and must be approached by different methods.

Not only has the fact of diffusion been proved, but we have also gained important knowledge of how it works. It appears that, other things being equal, the first elements to be diffused from any center will have spread farther at any point in time than elements diffused subsequently. It is further possible to point to numerous cases in which an element is still alive and spreading about the margins of an area in which it once existed long after it has died out in the intervening regions. The concept of marginal survivals, which has been based upon this, is the mainstay of historic reconstructionists.

Unfortunately for these reconstructionists and for systematizers in general, the exceptions to the rule of systematic spread of elements in space and time seem to be at least as numerous as the agreements. It can be shown that many traits have spread irregularly, traveling fast and far in certain directions and slowly if at all in others. It can also be shown that some traits have diffused much more rapidly than others. Thus the use of tobacco spread over the whole of the Old World in about two centuries, while the use of writing, intrinsically much more valuable, required at least three thousand years to spread from its point of origin in the Near East to northwestern Europe. It is only recently that it has come to be realized that the key to these irregularities of diffusion must be sought less in the qualities of the diffused elements themselves than in those of the cultures which are exposed to them. It would seem obvious that in the consummation of the diffusion process the receiving group is of extreme importance, yet this part of it has hardly been studied at all. The recent increase of interest in Acculturation, aside from that in its psychological aspects, represents a shift of attention from the wanderings of culture

elements to what happens when new elements are presented to a society. We know the society's response may range all the way from complete rejection through acceptance with varying degrees of modification and reinterpretation to complete acceptance, and we believe that the nature of the response is determined primarily by the nature of the preexisting culture, the matrix into which the new element must be fitted. This aspect of culture dynamics is still almost unexplored and offers one of the most promising fields for further research.

In their enthusiasm at discovering that elements of culture can travel independently and that most cultures owe the bulk of their content to borrowing from many sources, the diffusionists have tended to overlook another and equally important aspect of the total problem. At least one member of this school has gone so far as to refer to culture as a thing of shreds and patches. It might be countered that so is a newly completed rag rug. Irrespective of their origins, the elements which have been brought together to form any culture constitute a fabric, not a disorganized heap. Cultures are patterned wholes whose component items are always to some degree mutually adjusted. This integration of culture has become the focal point for the studies of the recently developed functional school of ethnologists. Their work has already thrown important light on the structure of cultures, the interrelations of their parts and the relation of culture elements to the needs of the individual and group. However, enthusiasm for this new line of approach and a desire to sever all ties with the older schools have betrayed the functionalists into taking certain extreme positions. They seem to ignore the fact that although cultures may be integrated wholes, they show all degrees of integration between their various elements and may, at any point in time, include unresolved conflicts. Members of one division of the functionalists have, furthermore, avowedly limited themselves to the study of the synchronic relations of culture elements, *i.e.*, those existing at a single point in time. This position, if consistently maintained, permits the study of the structure of cultures but completely rules out the study of all dynamic processes. Even the complex interactions of culture elements take place in a time dimension. In the very nature of things cause must precede effect.

Actually, even members of this group of functionalists do not adhere too rigidly to their self-imposed limitations and probably will adhere to them less and less as time goes on. It must be plain to any one familiar with cultural phenomena that every culture is a continuum existing in time as well as space and that this continuum is in constant process of simultaneous integration and disintegration. New elements are always coming in and old ones dropping out with accompanying readjustments. Such changes are never instantaneous and a cross section of the culture continuum taken at any point in its length inevitably catches and artificially fixes some conditions which must, in their very nature, be transitory. It bears very much the same relation to the continuum that a single picture clipped from the middle of a cinema reel bears to the total action which the reel records. Such a picture may show an actor hanging in air, caught in the middle of a leap, but this does not prove that he can continue hanging there. Neither does it contribute to our understanding of the laws of gravitation.

In spite of the diverse aims and claims of the various schools the study of culture has now progressed far enough to enable us to get some picture of the problems with which students of culture dynamics have to deal. The processes relating to culture can be grouped under two main headings: those relating to culture growth and those relating to culture performance. Both have to be observed in time, but the processes of the second group operate over much shorter intervals, and their observation does not require use of the historic approach. The processes of culture growth can be further subdivided into those by which new elements are introduced into culture, those by which superseded elements are eliminated and those by which new elements are integrated with the preexisting configuration. Thanks to studies of invention and diffusion we already have some understanding of the introductory processes, but we know very little about those of elimination or integration. It would seem that the present world-wide condition of rapid cultural change offers a particularly good opportunity for investigations of this sort. The processes relating to culture performance can be divided into those deriving from the interaction of culture elements and those deriving from the relations of culture elements to the needs of the individual and the society. In this field we have hardly progressed beyond a realization of the extraordinary complexity of the material with which we have to deal. The interrelations of various culture elements in action are so intricate as almost to defy analysis. Perhaps the best clue to such interrelations can be obtained through the study of situations of culture change. The extent and nature of the readjustments which follow the introduction of a new element or the loss of an old one are an indication of the extent of this element's functional relationships. The relations of culture elements to the needs of the individual and of society are, if possible, even more complex. Even the needs, the logical starting point for such a study, are extremely hard to define in terms exact enough for purposes of culture analysis. A few fundamental needs of society and the physiological needs of the indi-

vidual can be discerned, but these are certainly inadequate as a basis for the study of culture. All cultures have a vastly richer content than that which would suffice to insure the survival of the societies which bear them. It is clear that the individual has psychological and emotional needs as well as physiological ones and that part of the function of culture is to provide satisfaction for these, but we must wait for the psychologist to tell us exactly what these needs are.

It will be many years before ethnologists obtain a clear understanding of these processes, and even when they do their work will not be finished. Everything that the ethnologist can observe, record or analyze is a product of the interaction of three elements—culture, society and the individual. The interrelation of these elements may be made clearer if we liken the culture to a symphony, the society to an orchestra and the individual to a musician playing his prescribed part but always playing it a little off key. Society, through the medium of its component individuals, is responsible for the overt expression of culture and for its perpetuation. No culture can exist without a society. Conversely, no society can exist without a culture. It is culture which provides the techniques for group living and the stereotypes which make the behavior of individuals sufficiently predictable for them to be able to work together. It transforms what would otherwise be a mere aggregate of persons into an integrated, functional whole. Lastly, it is the individual who is responsible, in the last analysis, for all additions to culture. Every new idea must originate with some person. Nevertheless, culture and society together shape the individual, changing his general needs to concrete desires and making his adult personality a compromise between his demands and theirs. In every situation culture, society and the individual are so interdependent and in a state of such constant interaction that an attempt to study any one of the three without constant reference to the other two can lead to only meager and mutilated conclusions. Even in the study of the individual, which psychology has made its special province, it is becoming clear that any approach to personality which fails to take culture and society into account soon reaches a dead end. Just as the various schools of ethnology, with their limited aims and approaches, must ultimately fuse into a single science of culture, so we may expect this science of culture to finally fuse and disappear into a larger science of human behavior. This will be the authentic Anthropology, the study of man.

SCIENTIFIC EVENTS

THE SPREAD OF ELM DISEASE IN ENGLAND

ACCORDING to an article in the London *Times* ten years have now passed since the first case in England of elm disease was identified by Dr. Malcolm Wilson, of the University of Edinburgh. This was a tree growing at Totteridge, Herts, and although the first recorded case, there is reason to believe that the disease had already been present for some years without attracting notice. During the past decade the disease has either spread or been found to occur over the whole of England and a large part of Wales, though it has not crossed the border into Scotland nor is it yet known in Ireland.

From a report received by the forestry commissioners it appears that the disease spreads slowly in some localities and quickly in others, but taking the country as a whole the progress is not very perceptible. In many of the districts visited there were actually fewer trees infected in 1937 than in 1936; on the other hand, those trees that were attacked showed a more pronounced form of die-back. Even in the most severely affected areas, where up to nearly 50 per cent. of the elms have been killed, there remains a residue of healthy trees which, it is to be hoped, will continue to survive and prove resistant to the fungus.

The *Times* states that the American investigators who have been studying the disease in England have demonstrated by inoculation tests that the different species and varieties of elm show varying degrees of resistance to attack. It seems that the American elm (*Ulmus americana*) is much more susceptible than the common forms of elm grown in England; hence, possibly, the very rapid death of attacked elms which is a feature of the disease in the United States. Of the British elms tested, the least susceptible variety commonly grown appears to be the Wheatley elm (*Ulmus stricta Wheatleyi*). In view of the ease with which elms can be propagated from suckers or layers, the most hopeful line of work for the future is the discovery of resistant individuals from which to raise stocks to take the place of trees that have fallen victim to the disease. Work along these lines is proceeding.

THE CANADIAN DEPARTMENT OF MINES AND RESOURCES

A COMPREHENSIVE account of its principal activities during the year is presented by the Department of Mines and Resources, Ottawa, in its report for the fiscal year ending March 31, 1937. The report covers the work of the former Departments of Mines, Interior, Indian Affairs and Immigration from March to December, 1936, when these departments were amalgamated to form the present department, and of the new department from December to the end of the fiscal year.

The functions of the five branches of the department, each of which is headed by a director, are summarized in the introductory section. This section includes also a statement showing the total amount of revenue and expenditure for the fiscal year. In other sections the respective directors review the activities of the Mines and Geology Branch; Lands, Parks and Forests Branch; Surveys and Engineering Branch; Indian Affairs Branch; and Immigration Branch.

Dealing with mining, the report notes that the department has continued to encourage the industry wherever possible, with research and investigative work in geology, mineral technology, and mineral economics as a central feature of its services and also that much greater attention than in former years was given toward developing among Canadians an appreciation of the economic importance of the industry. One of the activities of the Lands, Parks and Forests Branch is the work of the Dominion Forest Service, a division of the department engaged in the study of problems relating to the protection, development and utilization of the forests of Canada. The branch is responsible also for the administration of the mineral, fur and other natural resources of Yukon and the Northwest Territories; and of the National Parks of Canada. The work of the Dominion Observatories is under the supervision of the Surveys and Engineering Branch. Of greater practical importance is the work of the branch carried out through the agencies of the International Boundary Commission, the Dominion Water and Power Bureau; the Engineering and Construction Service; the Geodetic Service of Canada, and the Hydrographic and Map Service.

Indian trust funds at the close of the fiscal year amounted to approximately $14,000,000. Collections during the year amounted to $1,184,800, and the expenditure was $1,073,800. Money for the funds are derived from the sale of land and timber, from rents and from capitalized annuities. The funds are credited to 475 accounts belonging to Indian bands throughout Canada. They are administered by the Indian Affairs Branch, which is responsible also for the administration of the Indian Act, the maintenance of Indian agencies and the provision of medical welfare and training services.

Each section of the report is accompanied by a chart showing the organization of the branch concerned, and an organization chart of the department as a whole is included.

GRANTS OF THE CARNEGIE CORPORATION TO THE AMERICAN ASSOCIATION OF MUSEUMS

THE Carnegie Corporation of New York, on January 20, made a gift to the American Association of Museums to provide grants-in-aid for foreign travel and study during the year 1938 by members of the staffs of museums. The following statement of conditions has been issued by Herbert E. Winlock, president of the association.

It often happens that the members of the staffs of American museums have no opportunity to become acquainted at first hand with many phases of their chosen subjects when their normal museum duties do not send them afield, and when they are personally not able to afford the expense of foreign travel to those regions, an acquaintance with which would improve their professional standing. To assist such museum workers to broaden their experience—and thus to increase their usefulness in the institution in which they are employed—the Carnegie Corporation of New York has made an appropriation to the American Association of Museums to provide grants-in-aid for travel during the year 1938 by members of the staffs of art, science, history and industry museums:

A. Whose principal duties are of a professional nature;

B. Whose salary is not over $3,000; who have not the private means to travel abroad, and whose duties in their museums would not normally give them such opportunities, and

C. To whom their institutions will give at least two months' leave on full pay for the travel for which the grant is made.

These grants are for traveling expenses to places where the applicant will have an opportunity to broaden his background by familiarizing himself with the institutions, collections, or regions which are of importance in the study of his particular professional subjects.

It is planned that the average grant will not exceed $500 except under most unusual circumstances, and that it will not amount to as much as $1,000 in any case.

Such grants are to be made only on applications fully endorsed by the director of the applicant's museum. The form of application is given below. Facts should be given in the order in which they are here set forth.

THE MUSEUM OF NATURAL HISTORY OF THE UNIVERSITY OF OREGON

THE University of Oregon formally opened its exhibits in natural history on January 20. The museum offers exhibits in addition to study materials in the fields of anthropology, botany, geology, paleontology and zoology. Lack of adequate space heretofore has prevented the arrangement of an exhibition hall. An excellent room about 72 by 45 feet on the second floor of Condon Hall has been made available with the completion of the new library.

The museum naturally is regional in its emphasis, although for educational purposes specimens from other areas are included in the exhibits. This is especially true in the ethnographic exhibits. It had its origin in the collections made by Dr. Condon when he began his work in the state and opened up the fields in paleontology and geology which have contributed so

richly ever since. He also made an interesting collection of archeological materials, mostly from the Columbia Valley region about The Dalles. This core, formerly known as the Condon Cabinet, has been added to by generous gifts since that time and the collections made by staff members and field parties from the university. Part of the Condon geological and paleontological collections were transferred to the Oregon State Agricultural College for study purposes with the transfer of major work in sciences to that institution in 1932. The herbarium contains about 60,000 sheets which give a good picture of the flora of Oregon. Professor L. F. Henderson has contributed largely to make this collection the valuable one it is. In zoology the Prill collection of Oregon birds was a gift of Dr. A. G. Prill, of Scio, Ore. The study collections contain several thousand skins of mammals of the state in addition to bird skins.

The study collections are available to competent students for use upon application to the appropriate curator. The divisions of the museum and the curators are:

The Condon Museum of Geology: Dr. W. D. Smith, professor of geology and geography, curator.

The Herbarium: Professor L. F. Henderson, research professor of botany, curator; Dr. Leroy Detling, assistant professor of botany, assistant curator.

The Oregon State Museum of Anthropology: Established by act of the Legislature, 1933. Dr. L. S. Cressman, professor of anthropology, curator.

The Museum of Zoology: Dr. R. R. Huestis, professor of zoology, curator of vertebrate collections.

L. S. CRESSMAN,
Director

THE PEABODY MUSEUM OF YALE UNIVERSITY

Two new exhibits were opened on February 22 by the Peabody Museum of Natural History of Yale University in honor of the graduates who attended on the occasion of the twenty-fifth annual Alumni University Day. Both will form part of the permanent exhibits of the museum.

One of the new exhibits in the Great Hall of the museum is the mounted skeleton of a relatively small plant-feeding dinosaur—Comptosaurus—which lived and died some hundred and twenty million years ago. This was collected near Como, Wyo., in 1880 and is a part of the Marsh Collection, having been in storage for a period of nearly sixty years. It is mounted beneath the head and neck of the great Brontosaurus and forms a remarkable contrast in size, gait and general appearance of these ruling reptiles of the age which bears their name.

The second exhibit is the "Hall of Man," arranged by Professor Cornelius Osgood, curator of anthropology, in which there are two innovations. First, the specimens have been arranged so as to illustrate various anthropological concepts, and are not exhibited merely as curios. Second, methods of exhibition have been modernized. Use has been made of contrasting color, of various electrical lighting devices and of revolving turntables in order to make the exhibits more interesting and meaningful to the public.

A number of the remaining cases in the hall illustrate factors which tend to counterbalance the fundamental similarity of mankind, making for the apparent differences in culture rather than the similarities. Two table cases present the evolution of culture in Europe, exemplifying the fact that culture can develop independently in different places. The stages of development are shown from the time of the first tool down to the modern age of steel. A group of seven cases illustrates the adaptation of man to his environment. They indicate that man has had to adjust his culture to the conditions surrounding him, thereby making himself different from people who live in a different environment.

Several cases deal with the manner in which culture changes. One of these illustrates how an element of culture has spread from its place of origin to neighboring peoples. Another case illustrates the fact that similar elements of culture can develop in different parts of the world, either from similar or from different antecedents. In the former case, the anthropologist calls the occurrence parallelism, and in the latter case, convergence. Three other anthropological concepts are illustrated. Culture itself is defined in one exhibit, and its development is contrasted with organic growth. Another exhibit illustrates the anthropological practice of classifying peoples in adjacent geographic areas on the basis of similarities in culture. There is an exhibit illustrating the development of man and the great apes. This exhibit emphasizes the fact that man did not develop from the apes, as is commonly assumed, but that both man and the apes appear to have developed from a common ancestor. Finally, there is an exhibit to suggest the application of anthropology to modern life.

THE MEETING OF THE ENTOMOLOGISTS AT RICHMOND

THE Entomological Society of America and the American Association of Economic Entomologists will hold their annual meetings in Richmond, Va., during the convention of the American Association for the Advancement of Science next December.

W. D. Reed is chairman of the state committee on entomological arrangements. Nearly 500 delegates, representing both groups, will attend, and a full program of scientific papers and exhibits relating to insects and their control will be presented. The state committee on arrangements recently held its first

meeting at the John Marshall Hotel to make plans for entertaining and accommodating the large delegation. Members of this committee include: G. T. French, state entomologist, Virginia Department of Agriculture, in charge of exhibits; Harry G. Walker, Virginia Truck Experiment Station, Norfolk, banquet; Professor J. W. Bailey, department of biology, University of Richmond, group meetings; Paul D. Sanders, editor, *Southern Planter,* publicity, and W. D. Reed, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, chairman. Dr. E. N. Cory, professor of entomology at the University of Maryland, representing entomologists, visited Richmond in January to inspect rooming and meeting facilities.

Dr. A. L. Melander, of the City College of New York, is president, and Dr. C. E. Mickel, of the University of Minnesota, is secretary of the Entomological Society of America, which has a membership of 1,000. The American Association of Economic Entomologists has a membership of about 1,200, including 50 members in foreign countries. Professor J. J. Davis, of Purdue University, is president and Dr. Cory is secretary of this group.

SCIENTIFIC NOTES AND NEWS

A TESTIMONIAL dinner was given under the auspices of the Philippine Community of Washington, in honor of Professor Frank Lamson-Scribner, first director of agriculture in the Philippines, at Washington, D. C., on February 5. Harry T. Edwards, formerly director of agriculture in the Philippines, and Dr. Elmer D. Merrill, first director of the Philippine Bureau of Science, were the principal speakers. Among those present who also spoke were Quintin Paredes, Philippine commissioner in Washington, and José Romero, majority floor leader in the Philippines. Dr. Lamson-Scribner died on February 22.

DR. ALFRED NEWTON RICHARDS, for twenty-eight years professor of pharmacology at the University of Pennsylvania, received on March 9 the Philadelphia Award, which was presented to him at the Academy of Music in recognition of his work on kidney action. The award, established by Edward W. Bok, consists of $10,000, a gold medallion and an engrossed scroll. Dr. Edwin G. Conklin, of Princeton University, executive vice-president of the American Philosophical Society, made the presentation, and the principal address was given by Waldemar B. Kaempffert, science editor of *The New York Times.*

DR. PHOEBUS A. LEVENE, member of the Rockefeller Institute for Medical Research for twenty-one years, received the William H. Nichols Medal of the New York Section of the American Chemical Society at a joint dinner of the section and the Society of Chemical Industry on March 11 at the Hotel Pennsylvania.

THE Institute of Metals, London, has made the first award of its new medal to Sir William Bragg, president of the Royal Society. The presentation was made on March 8. The medal—in platinum—is given for outstanding services to non-ferrous metallurgy.

THE council of the British Iron and Steel Institute has awarded the Bessemer Gold Medal for 1938 to Dr. C. H. Desch, superintendent of the National Physical Laboratory, Teddington. The presentation will be made at the annual general meeting of the institute on May 4. Dr. Desch has long been distinguished as a teacher of metallurgical chemistry. In 1932 he was appointed to succeed the late Dr. W. Rosenhain as superintendent of the metallurgical department of the National Physical Laboratory.

DR. GUSTAVUS A. EISEN, of New York City, the oldest living corporate member of the California Academy of Sciences, was elected an honorary member of the academy at its annual meeting on February 16. Dr. Eisen has published researches in zoology, cytology, botany, archeology and art history. In 1890, through the California Academy of Sciences, he initiated the movement to set aside the area containing the Sequoia Grove of Big Trees in the Sierra Nevadas as the Sequoia National Park.

SIR ALBERT SEWARD, formerly master of Downing College and professor of botany in the University of Cambridge, has been elected a trustee of the British Museum.

Nature states that Dr. Eugen Fischer, professor of anthropology at the University of Berlin, and Dr. Hermann Lautensach, professor of geography at Greifswald, have been nominated for honorary doctorates by the University of Coimbra.

OFFICERS of the American Microscopical Society for 1938 were elected at the Indianapolis meeting as follows: *President,* Dr. C. W. Dodge, Missouri Botanical Garden, St. Louis; *First Vice-president,* Dr. F. E. Eggleton, University of Michigan; *Second Vice-president,* Dr. Harold Kirby, University of California; *Secretary,* Dr. J. E. Ackert, Kansas State College, Manhattan; *Treasurer,* Dr. A. M. Chickering, Albion College, Michigan. Dr. Ackert and Dr. Chickering were elected members of the council of the American Association for the Advancement of Science.

AT the meeting at Baltimore of the Wildlife Society on February 14 officers elected were: *President,* A. A. Allen, Cornell University; *Vice-president,* T. H. Langlois, Ohio; *Secretary,* Victor H. Cahalane, Washington, D. C., and *Treasurer,* Warren W. Chase, Des Moines, Iowa. W. L. McAtee was reappointed editor of the *Journal of Wildlife Management.* W. L. Finley was elected a trustee and E. B. Komarek and James Moffitt were elected to the membership committee. Among the results of the business meeting was the passage of a resolution calling upon authorities concerned to investigate and put into effect methods of control of the wilt (*Cephalosporium* sp.) which seemingly threatens the existence of the native American persimmon, an important wildlife food in the southeastern United States.

AT the annual meeting of the California Academy of Sciences held on February 16 the result of the election of the academy for the year 1938 was announced as follows: *President,* Dr. F. M. MacFarland; *First Vice-president,* the Honorable Herbert Hoover; *Second Vice-president,* Dr. E. P. Meinecke; *Corresponding Secretary,* Dr. Charles L. Camp; *Recording Secretary,* Dr. Olaf P. Jenkins; *Treasurer,* Templeton Crocker; *Trustee,* Louis F. Monteagle, to serve five years. Dr. Chauncey D. Leake was appointed librarian by the council to succeed the late Dr. Emmet Rixford.

MAJOR-GENERAL E. W. C. BRADFIELD, director-general of the Indian Medical Service, has been elected president of the Medical Council of India.

DR. G. M. BENNETT, Firth professor of chemistry at the University of Sheffield, has been appointed to the university chair of chemistry tenable at King's College, London.

DR. E. J. WILLIAMS, Leverhulme Foundation lecturer at the University of Liverpool, has been appointed to the professorship of physics of University College, Aberystwyth, Wales.

PROFESSOR ALLEN C. TESTER has been granted two years' leave of absence from the State University of Iowa to accept a position as geologist in charge of a district for the Socony-Vacuum Company of Colombia.

THE President has approved the appointment of the following as delegates on the part of the United States to the ninth International Ornithological Congress, which will be held at Rouen, France, from May 9 to May 13: Alexander Wetmore, assistant secretary, Smithsonian Institution, in charge of the United States National Museum, *chairman of the delegation;* James P. Chapin, associate curator of Continental Old World birds, the American Museum of Natural History; James Cowan Greenway, Jr., assistant curator of birds, Museum of Comparative Zoology, Cambridge; Lawrence E. Hicks, Bureau of the Biological Survey, Department of Agriculture, Columbus, Ohio, and T. Gilbert Pearson, president emeritus, National Association of Audubon Societies, New York.

DR. MARSTON TAYLOR BOGERT, professor of organic chemistry in Columbia University, has been appointed an official delegate of the United States Government to the thirteenth conference of the International Union of Chemistry and the tenth International Congress of Chemistry, to be held jointly in Rome from May 15 to 21. Dr. Bogert will serve as president of the Section on Chemistry and National Defense of the congress and will deliver an address in Italian on "The Chemist as a Defender of His Fatherland" at the opening session. Professor Nicola Parravano, of Rome, is president of the congress.

FRANK TOSE, chief of exhibits of the Museum of the California Academy of Sciences, has recently returned from an eight months trip to Australia and New Zealand. Mr. Tose was sent by the Carnegie Corporation of New York to visit the principal museums of those countries and to extend advice and aid with the view of modernization of their natural history exhibits, especially of habitat groups. Aside from visits and personal conferences with museum directors and other officials, Mr. Tose conducted demonstration classes in museum technique for eight weeks each in Sydney and Wellington, which were attended by preparators and others connected with the different museums.

THE London *Times* reports that M. Jean Verhogen, of the University of Brussels, has arrived at Kivu by air to investigate the recent eruption of the Nyamlagira volcano in the Belgian Congo on behalf of the Jacques Cassel Foundation and the Institute of National Parks.

DR. F. W. GAIL, head of the department of botany at the University of Idaho, has leave of absence this semester and is visiting England, Germany, France, Italy and Sweden. During his absence Dr. R. F. Daubenmire is in charge of the department.

DR. HERMANN WEYL, professor of mathematics of the Institute for Advanced Study at Princeton, N. J., gave the eighth Joseph Henry lecture before the Philosophical Society of Washington on March 12. His subject was "Symmetry."

THE Gehrmann Lectures of the University of Illinois for 1937–1938 will be delivered on March 23, 24 and 25 by Dr. Thomas M. Rivers, director of the Hospital of the Rockefeller Institute for Medical Research, New York City. The subjects of the individual lectures will be: "Viruses and Virus Diseases"; "Cultiva-

tion of Vaccine Virus: Methods Employed, Types of Information Obtained, Jennerian Prophylaxis with Cultured Virus," "Poliomyelitis."

DR. W. F. G. SWANN, of the Bartol Research Foundation of the Franklin Institute, will give the annual Sigma Xi lecture at the Carnegie Institute of Technology on Saturday evening, April 2. He will discuss "What Has Become of Reality in Modern Physics?"

DR. FRANK C. WHITMORE, research professor of organic chemistry and dean of the School of Chemistry and Physics of the Pennsylvania State College, spoke on March 10 before the Lancaster Branch of the American Association for the Advancement of Science. His subject was "Chemistry, a Blessing or What?"

DR. DAVID J. DAVIS, professor of pathology, head of the department of pathology, bacteriology and public health and dean of the College of Medicine of the University of Illinois, will deliver the second Christian Fenger Lecture of the Institute of Medicine of Chicago and the Chicago Pathological Society on Friday, March 25. His subject will be "Pathology as a Basis for the Study of Health."

DR. A. B. STOUT, of the New York Botanical Garden, gave an address on "Incompatibilities in Flowering Plants" on the evening of February 14, before the Plant Science Club of Yale University.

DR. M. A. TUVE, chief physicist of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, gave on March 1 at the institution an illustrated evening lecture on "The Forces which Govern the Atomic Nucleus."

DURING a recent visit to Lincoln, Nebr., Professor Paul J. Hanzlik, chairman of the department of pharmacology of Stanford University, made an address before the Society of Sigma Xi on "Purkinje's Pioneer Self-Experiments in Psycho-Pharmacology," and gave two lectures before the College of Pharmacy on "Antitoxic and Protective Actions of Dyes" and on "Oral Treatment and Control of Syphilis with Sobisminol, a New Bismuth Compound."

THE first Congress on the Chemistry of Wood and the fourth International Conference on Timber Utilization will be held jointly from July 5 to 8 in the House of Industry in Vienna.

THE fourteenth annual meeting of the Pennsylvania Academy of Science will be held under the presidency of Dr. George H. Ashley, state geologist for Pennsylvania, on April 15 and 16, at Bucknell University, Lewisburg, Pa. The Junior Academy of Science will meet simultaneously. The annual dinner and presidential address are scheduled for the evening of April 15. During the meetings the symposium on "Methods of Teaching Science" is planned. Further information can be obtained from the secretary, Dr. V. Earl Light, Lebanon Valley College, Annville, Pa.

THE Arizona Anthropological Association has been formed in Phoenix "for the purpose of sponsoring anthropological research and for the dissemination of any knowledge which might accrue from such research." The officers of the newly incorporated association are: Odd S. Halseth, *president;* Dr. R. E. Solosth, *chairman of the executive board,* and Thora Rollins, *secretary.* The headquarters of the association is the Pueblo Grande Laboratory. It already has considerable assets and plans are under way for the sponsoring of a major field project. This project will include both physical and social anthropology, as well as linguistic and ethno-botanical studies.

A NATIONAL exhibition of the works of John J. Audubon will open at the Academy of Natural Sciences of Philadelphia on April 26. The exhibition will mark the one hundredth anniversary of the publication of the elephant folio of "The Birds of America" which was completed in London in 1838, and it will bring together a comprehensive collection of material from museums, universities and private collectors throughout the country. The exhibition will be divided into eight divisions: Audubon's personal relics, letters and journals, chalk and oil portraits of his friends, original paintings of the birds and early natural history sketches, original portraits of the quadrupeds, a display showing the steps in the production of the wild turkey plate, engravings from the elephant folio and the various editions that Audubon's work have appeared in.

DR. FREDERICK BEDELL, emeritus professor of physics of Cornell University, by a ruling of the New York State Court of Appeals, has received the award of $100,000 previously made by referee's judgment, to recover money and royalties from the Dictograph Products on a bone-conduction hearing aid for the deaf.

IT has been decided to extend the time for filing applications for the Walter Rathbone Bacon scholarship of the Smithsonian Institution from March 15 to April 15. (See SCIENCE, March 4, p. 211.)

ACQUISITION of lands needed to complete the Great Smoky Mountains National Park in North Carolina and Tennessee is authorized by a bill which has been signed by President Roosevelt. Approximately 410,000 acres within the park area have already been acquired by the Federal Government, principally by donation, leaving approximately 26,000 acres of privately owned lands yet to be acquired. Steps to acquire these lands will be taken by the department

when an appropriation is made by Congress pursuant to the authorization.

THE International Association of Milk Sanitarians has inaugurated the publication of the *Journal of Milk Technology*, a bi-monthly journal, to replace their annual yearbook series which had published the transactions of the association for the last twenty-five years. The new journal is the official organ of the association and will publish the papers which will be presented at the annual meetings as well as contributed papers which deal with the technology of dairy products. All business matters such as advertising, subscriptions, reprints, etc., are handled by the managing editor, William B. Palmer, East Orange, N. J. All matters regarding manuscripts, editorials, news items, announcements and other reading material are handled by Dr. J. H. Shrader, of East Orange, N. J.

DISCUSSION

BIOLOGICAL ABSTRACTS—LAST CALL

A NEW board has taken hold of *Biological Abstracts*, made its study and reached a decision. *Biological Abstracts* must go on—go on not merely, but score an outstanding success! It's an obligation of simple decency, quite aside from scientific necessity.

We have asked and received a generous grant to help establish *Biological Abstracts* during the course of the past eleven years.

Even with emergency grants, together with some help from other sources, we are to-day earning only 40 per cent. of our expenses. At the end of eleven years just 700 American biologists are on the subscription list, and a grand total of but 2,000 copies, personal, institutional and industrial, are taken the world over, with 600 of these abroad. Though sponsored by the Union of American Biological Societies, only one of these twenty societies has made a regular contribution, and to the end of 1937 only this one had laid an assessment on its membership for the support of *Abstracts*.

How our fellow scientists shame us! For see: Every member of the American Psychological Association has half his dues of $10 a year go to *Psychological Abstracts*, and he gets it. Something like $3.50 of the physicist's dues in the American Physical Society goes to support *Science Abstracts*, while from the American Chemical Society's treasury as well as from industry heavy grants are made annually for the publication of *Chemical Abstracts*, to which there are nearly 12,500 subscribers.

This disgraceful situation challenged the pride of a little group of younger biologists, who late in the year accepted the duty of framing a new plan. Time was short. They had no opportunity for far-reaching studies. Immediate action was necessary. They hit upon the scheme so successfully operated by the H. W. Wilson Company, which among other things issues a series of periodical indices, to agricultural, art, educational and engineering journals. Here the charge is made to vary with the number of such journals taken.

Adapting this method to *Biological Abstracts*, the Committee on Arrangements set a subscription scale based on number, not of biological journals, but of biologists in the institutions. Thus

$ 25.00	in	case	of	0– 3	biologists
45.00	"	"	"	4– 6	"
65.00	"	"	"	7–10	"
85.00	"	"	"	11–20	"
105.00	"	"	"	21–50	"
200.00	"	"	"	51–	"

with $7.00 the charge for extra copies, including personal subscriptions in such institutions.

The plan met with sharp and organized opposition on the part of librarians. For it quickly appeared that, though they paid the Wilson bills, they were becoming increasingly restive under them and at the time had committees at work to secure relief. Ours was thus the straw to break the camel's back.

So at the instance of certain of their number, the committee shifted these quotas from library assessments to institutional subsidies, pledged to a two-year limit and a general flat rate thereafter if publication continued.

Despite the shift, however, somewhat less than $23,000 has been received in subscription pledges. As much more is necessary even on a budget cut to the bone. Closing this gap is now a pressing claim of honor on every biologist in America. If *Biological Abstracts* is to be saved, it must be done before March is over. We can not afford to suspend the staff and interrupt the flow of journals. It is far easier and cheaper to strengthen a going concern than to resurrect a dead one. Unless new subscriptions are promptly pledged (not necessarily paid now), moneys on hand for 1938 will be returned to subscribers.

The problem belongs to the biologists. This is a last call on the biological organizations or biological leaders in all institutions to take *immediate steps* for securing the required quotas from their respective institutions. This means at least an agreement with the librarian in each case and perhaps with the general administration as to how the charge is to be met. It has been suggested that the library's minimum share should be $25, though many in the emergency will be glad to assume a much larger portion or even all. But the obligation is the biologists'. They must engineer the deal for the institution's total and then turn in their

personal subscriptions as never before. And they must do it now or never. We beg this.

Fortunately there is no deficit to wipe out. The year 1937 closed with some $12,000 on hand, just about enough to cover the printing bill of the three indices in arrears. But the staff can not be retained unless publication is to continue. If salaries have to come from this index fund, drastic editing of the remaining indicies must be resorted to. The board does not feel justified in starting Volume 12 till about $40,000 in subscriptions is assured, though the text of number 1 has long been ready for the press.

This number would cover the literature from December, 1937, into 1938. The second would complete the 1937 arrearage. Thereafter coverage would be prompt, and it would expand with expanding resources. Already several societies have taken action to give support. Others will act in March. It will not be long before it is a general habit. We have no fear of the future if we can but get through the present squeeze.

We are most fortunate in our new editor, Dr. J. E. Flynn. He has had long experience, possesses a cool head, promises no miracles and loves *Biological Abstracts* like a child. At great personal sacrifice he and his devoted staff work on margins all too narrow. They deserve well of us. In after time, this little group will hold an honored place in the annals of American biology.

So, too, the University of Pennsylvania, which so generously provides free quarters. And most of all the foundation which so willingly made possible the initiation of this project.

A new board of trustees took office in mid-February. They are: George S. Avery, Jr., Connecticut College; Howard P. Barss, U. S. Department of Agriculture; A. F. Blakeslee, Carnegie Institution; Paul R. Burkholder, Jr., Connecticut College; Anton J. Carlson, University of Chicago; Alden B. Dawson, Harvard University; Hubert B. Goodrich, Wesleyan University; A. P. Hitchens, Army Medical College; George W. Hunter, III, Wesleyan University; D. D. Irish, Dow Chemical Company; M. Llewellyn Raney, University of Chicago. The committee on arrangements gives way to an executive committee, consisting of Messrs. Hunter (*chairman*), Burkholder and Raney.

Mistakes your leaders old and new have made. *Abstracts* has not met expectations. The present plan works injustice and must be amended—later, not now while crossing a treacherous stream. In another year, we can change and then abandon the plan, while with many standing committees from the Union membership we can shape the journal to our needs. But all hands now to the rescue and afterward reform. Quickly, please.

Address Biological Abstracts, University of Pennsylvania, Philadelphia, Pennsylvania.

GEORGE W. HUNTER, III,
Chairman,
PAUL R. BURKHOLDER,
M. LLEWELLYN RANEY,
Executive Committee

THE NATURE OF VIRUSES[1]

DURING the last several years considerable evidence favoring the inanimate nature of viruses has been obtained. Perhaps it may be well to discuss some of the recent evidence that appears to favor the animate nature of viruses.

In an earlier paper[2] it was reported that juice extracted from mosaic tobacco plants contains a high concentration of material capable of producing stream double refraction, sometimes called anisotropy of flow. The concentration of this material parallels that of active virus in most cases; this and other evidence were considered to indicate that the virus is composed of sub-microscopic elongated particles. Stanley[3] refined what is apparently the same material and obtained it in the form of visible, spindle-shaped particles about 20 μ long $\times$ 0.4 μ wide, which were regarded as crystals and which gave the reactions of a protein. Wyckoff and Corey[4] x-rayed this material and from the x-ray pattern concluded that these particles are crystals. Bernal and Fankuchen[5] repeated the x-ray work and interpreted the results to indicate that Stanley's visible particles are not true crystals showing an indefinite repetition of identical units in three-dimensional space, but are composed of elongated molecules in the liquid crystalline state.

A majority of the workers on liquid crystals[6] appear to agree on the following explanation of the liquid crystalline state (this state is also sometimes called the mesomorphic, paracrystalline or anisotropic liquid state): Elongated molecules tend to come together and to orient themselves with the long axes of the molecules parallel, thus forming sub-microscopic elongated groups called swarms. In a suspension of material in this state the liquid does not necessarily show double refraction unless the swarms are oriented by streaming or by an electric or magnetic field. Upon standing, the swarms are supposed to come together, arranged with their long axes more or less parallel and

[1] The assistance of non-technical employees of the federal Works Progress Administration is acknowledged.

[2] W. N. Takahashi and T. E. Rawlins, SCIENCE, 81: 299–300, 1935.

[3] W. M. Stanley, *Phytopath.*, 26: 305–320, 1936.

[4] R. W. G. Wyckoff and R. B. Corey, *Jour. Biol. Chem.*, 116: 51–55, 1936.

[5] J. D. Bernal and I. Fankuchen, *Nature* (Lond.), 139: 1923, 1937.

[6] "Symposium on Liquid Crystals," *Trans. Faraday Soc.*, 29: 881–1084, 1933.

to form the larger, doubly refractive, groups that can be seen by viewing the quiet liquid between crossed nicols. These visible groups are called liquid crystals. Under polarized light they may be indistinguishable from similar groups called tactoids or microtactoids, which are supposed to consist of oriented, elongated, sub-microscopic crystals. Upon stirring, liquid crystals or tactoids may be disorganized and disappear from view but are again formed after standing. Bawden, Pirie, Bernal and Fankuchen[7] and the authors[8] have observed the stream double refraction in the refined tobacco mosaic virus protein, and the former workers have observed what appear to be prolate liquid crystals or tactoids, after the concentrated virus protein has stood for a time. From the above discussion it appears that the virus may exhibit at least some of the properties shown by liquid crystals and tactoids.

By the use of the ultracentrifuge, Ericksson-Quensel and Svedberg[9] and Wyckoff, Biscoe and Stanley[10] calculated the molecular weight of refined tobacco mosaic virus protein to be between 10 million and 17 million. Northrup[11] studied a refined nucleoprotein phage and calculated the molecular weight to be 200 to 300 million. He suggested that the phage and certain viruses may be enzymes. The highest molecular weight reported by Svedberg[12] for known enzymes is 82,800. The question at once arises as to why the virus nucleoproteins, supposed to cause certain infectious diseases, have "molecular weights" so much higher than known enzymes. Are these particle weights really molecular weights or are they the weights of aggregates of molecules? Bawden and Pirie[13] report that the refined virus proteins used in the determination of "molecular weights" are retained by filters having a pore size about eight times as great as that required to pass the same virus before the purification treatment. These results suggest that the virus particles within the living plant may have particle weights somewhat below those determined by centrifugation.

So far as we have been able to determine, none of the known enzymes that have been analyzed have been found to be made up of nucleoproteins. If the virus nucleoproteins are enzymes why are they all of the type of protein found in the nuclei of organisms rather than the types found in known enzymes?

Miescher,[14] Schmidt[15] and Rinne[16] have reported that a large proportion of the material in the heads of certain sperms is a doubly refractive nucleoprotein. Rinne reports that x-ray analysis of these sperms indicates that this material is in the liquid crystalline state. If living sperm cells show double refraction and x-ray patterns of the same type shown by the refined virus, as has been reported above, it is perhaps possible that tobacco mosaic virus may be a sub-microscopic, elongated organism composed largely or entirely of liquid crystalline nucleoprotein, and that such elongated organisms tend to become oriented by streaming or by standing to produce the double refraction that has been observed.

Barnard[17] has attempted to photograph virus particles by the use of ultra-violet light. In the vesicular fluids from animals affected with foot and mouth disease and with vesicular stomatitis he has photographed minute rod-shaped particles that certainly appear to be bacteria. These particles, like refined tobacco mosaic virus nucleoprotein[18] and like the nucleoprotein in chromosomes,[19] have been reported to show high absorption of wave-lengths in the neighborhood of 2570 Å. Certain enzymes and proteins other than nucleoproteins have been reported to show relatively little absorption of light in this region of the ultra-violet spectrum.[18,19] These results suggest the possibility that the bacterium-shaped particles photographed by Barnard may have a composition somewhat similar to that of refined tobacco mosaic nucleoprotein and to the nucleoproteins in chromosomes. More information must be obtained before conclusions can be reached regarding this relationship.

Bawden and Pirie[20] reported that tobacco mosaic is not appreciably hydrolyzed by proteolytic enzymes until the virus is inactivated by heating. This behavior toward enzymes is similar to that shown by organisms.

It is obvious that much of the above speculation is based on meager evidence; it is presented with the hope that it may stimulate further research in this field rather than that it may enable the reader to reach a conclusion regarding the nature of viruses.

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[7] F. C. Bawden, N. W. Pirie, J. D. Bernal and I. Fankuchen, *Nature* (Lond.), 138: 1051–1052, 1936.

[8] W. N. Takahashi and T. E. Rawlins, SCIENCE, 85: 103–104, 1937.

[9] I. Eriksson-Quensel and T. Svedberg, *Jour. Amer. Chem. Soc.*, 58: 1863–1867, 1936.

[10] R. W. G. Wyckoff, J. Biscoe and W. M. Stanley, *Jour. Biol. Chem.*, 117: 57–71, 1937.

[11] J. H. Northrup, SCIENCE, 86: 479–483, 1937.

[12] T. Svedberg, *Chem. Rev.*, 20: 82–98, 1937.

[13] F. C. Bawden and N. W. Pirie, *Proc. Roy. Soc. London*, Ser. B., 123: 274–320, 1937.

[14] F. Miescher, *Arch. Exp. Path. Pharm.*, 37: 100, 1896.

[15] W. J. Schmidt, *Zool. Jahrb. Abt. f. Allgem. Zool. u. Phys.*, 45: 177, 1928.

[16] F. Rinne, *Trans. Faraday Soc.*, 29: 1016–1032, 1933.

[17] J. E. Barnard, *Proc. Roy. Soc. London*, Ser. B., 124: 107–113, 1937.

[18] G. J. Lavin and W. M. Stanley, *Jour. Biol. Chem.*, 118: 269–274, 1937.

[19] T. Caspersson, *Zeit. f. Wissenschaft. Mikros.*, 53: 403–419, 1937.

[20] F. C. Bawden and N. W. Pirie, *Proc. Roy. Soc. London*, Ser. B., 274–320, 1937.

NICOTINIC ACID AND TOBACCO METABOLISM

RECENT interest attached to nicotinic acid in the vitamin B_2 complex[1, 2] prompts publication of the following observations on the marked effects obtained when nicotinic acid was supplied to green tobacco leaves. Using a specially developed method, tobacco plants were cultured with their cut stems in dilute aqueous solutions of nicotinic acid hydrochloride. Control plants were similarly cultured in tap water. Samples of 45 to 50 leaves were collected from each group for analysis. Preliminary observations showed large and apparently specific influences of nicotinic acid upon the degree and the duration of leaf turgidity, the rates of uptake of solution and of dry weight accumulation, and the postponement of permanent wilting. There was also an effect upon the synthesis of nicotine. One experiment conducted in diffuse light for five days revealed an increase of 190 per cent. in the amount of solution absorbed, a loss of only half as much dry weight, a survival period at least twice as long and an increase in total nicotine content of 31 per cent. compared with the corresponding values for the leaves of those plants cultured in water. Three subsequent experiments conducted for periods of two days each and in full light gave average increases of 52 per cent. in the amount of culture solution absorbed, 700 per cent. in the amount of dry weight gained, at least 100 per cent. in the length of the survival period, and 29 per cent. in the total amount of nicotine formed above the corresponding values for the controls.

These observations were incidental to an investigation of nicotine metabolism in the tobacco plant. A study of the significance of nicotinic acid in the metabolism and water relations of plant tissues is to be undertaken. The author wishes to express his sincere appreciation for the generous counsel and cooperation given by Professor Carl G. Deuber, whose efforts have made this and other studies possible.

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A FUNDAMENTAL PROBLEM CONCERNING THE LORENTZ CORRECTION TO THE THEORY OF REFRACTION

THE relation between the constitution of a conducting medium and its refractive index is a fundamental problem of classical physics to which attention has been devoted for many years but which even now is not completely solved. The question at issue is whether the force per unit charge exerted by an electric field upon an elementary charged particle in the medium should be taken simply as the Maxwellian electric intensity **E** (the Sellmeyer theory), or whether there should be added a contribution $(4\pi/3)\mathbf{P}$ (the Lorentz theory), **P** being the electric moment per unit volume produced by the electric field in the neighborhood of the charged particle under consideration.

For conduction electrons in metals under the influence of the steady and alternating electric fields ordinarily encountered in electrical engineering the validity of the Sellmeyer theory is universally taken for granted. The Lorentz theory would be inconsistent with Ohm's Law and would in fact render the medium electrically unstable. For the same reasons it may be regarded as beyond question that, for a rarefied gas rendered conducting by ionizing radiation, it is the Sellmeyer theory which must be used at sufficiently small oscillation-frequencies. When the discovery of reflection of radio waves from the ionosphere aroused particular interest in the electrical properties of an ionized medium, it was at first assumed that for such a medium the oscillation-frequency could be raised to the values used in radio communication without affecting the validity of the Sellmeyer theory. This view was challenged in 1929 by Hartree,[1] who expressed the opinion that it is the Lorentz theory which should be used in the ionosphere at radio frequencies. There followed considerable discussion which culminated in 1934 in a theoretical treatment of the subject by Darwin,[2] which seemed to point to the conclusion that the Sellmeyer theory should hold good in the ionosphere at radio frequencies.

An experiment for deciding between the two theories was first indicated by Ratcliffe[3] and subsequently described in detail by Goubau.[4] Goubau shows that, for reflection from the ionosphere of radio waves of frequency less than the gyromagnetic frequency, there is in middle latitudes a clear-cut distinction in the behavior of the extraordinary wave according to the two theories. Over the past year a large number of records showing magneto-ionic splitting of ionospheric echoes at these wave-frequencies have been obtained at the Kensington (Maryland) Experiment Station of this department, using the automatic multifrequency equipment developed here. Details of these observations will be published elsewhere. Comparison with Goubau's theoretical treatment leads us to believe that it is impossible to interpret these observations in terms of the Sellmeyer theory, but that no objection exists to their interpretation in terms of the Lorentz theory. It

[1] W. J. Dann, SCIENCE, 86: 616–617, 1937.
[2] P. J. Fouts, O. M. Helmer, S. Lepkovsky and T. H. Jukes, *Proc. Soc. Exp. Biol. and Med.*, 37: 405–407, 1937.

[1] *Proc. Camb. Phil. Soc.*, 25: 97–120, 1929; 27: 143–162, 1931.
[2] *Proc. Roy. Soc.*, A, 146: 17–46, 1934.
[3] *Wireless Engineer*, 10: 354–363, 1933.
[4] *Hochfrequenz.*, 44: 138–139, 1934.

would appear therefore that it is the Lorentz theory which must be used in the ionosphere at oscillation-frequencies employed in ordinary broadcasting. But since it is the Sellmeyer theory which must be used at sufficiently small oscillation-frequencies we are faced with the following problem: At what frequency and in what manner does the transition from the Sellmeyer to the Lorentz theory take place?

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SCIENTIFIC BOOKS

THERMODYNAMICS

Text-book of Thermodynamics. By PAUL S. EPSTEIN, xii + 406 pages, 15 × 22.8 cm. John Wiley and Sons, New York, 1937. $5.00.

THIS book will fill a need which in the last few years has rapidly become acute, namely, for a treatment for the physicist which should adequately discuss the applications of thermodynamics to the many new experimental facts, particularly those involving quantum phenomena. Until the appearance of this book any one giving a course in advanced thermodynamics had to refer his students to the periodical literature for such important topics as: low temperature phenomena, in particular specific heats, degradation phenomena and the phenomena of supraconductivity; the calculation of specific heats from spectroscopic data; the thermodynamics of electron clouds; the thermodynamics of magnetic behavior, particularly in the neighborhood of the Curie point; and the thermodynamics of the transformations of matter into radiation. All these, as well as the conventional critical exposition of the fundamentals and applications to systems in which chemical reactions may take place, are treated with adequate fullness.

The treatment is mostly from the phenomenological point of view, and in this respect marks a return to an earlier practise, the tendency in recent years having been to treat classical thermodynamics and statistics simultaneously. But the development of subject-matter in the last few years has proceeded to such a point that the simultaneous exposition of the phenomenological and the statistical points of view has become so cumbersome as to demand, in the opinon of the author, a return to the earlier practise. It may be added that there is a great gain in the logical coherence of an exposition mainly from the one point of view. At the same time some statistical analysis can not well be avoided; in particular, the probability interpretation of the second law receives due attention.

It is, I suppose, unavoidable that in a subject where it appears to be necessary to devote as much attention as in thermodynamics to a critical examination of fundamental concepts differences of opinion should arise. In this respect physicists seem open to the same reproach that they have so often directed against the philosophers of not being able to come to agreement. Thus, personally, I have never liked using the idea of a perfect gas to give the approach to the second law and the absolute temperature scale, in spite of the fact that it is the method of Planck and the method adopted in this book. It is admitted that the perfect gas is an idealization; it has always disquieted me logically to think that perhaps the second law might possibly have been slipped in somewhere in the process of idealization. The logical tactics of the whole situation, I believe, are modified essentially since the day of Planck's treatment by the discovery that no substance can obey the perfect gas equation down to 0° Abs. without violating natural principles. When the student comes to the discussion of the degradation of all gases near 0° Abs. will he not be justified in saying, "What right did you have to assume that the existence of a particular kind of idealized substance was compatible with the first and second laws when you now know that it is inconsistent with the 'third law'"?

The book contains a number of minor slips which could be easily corrected in a later edition. On page 82 is the statement, "Processes (in an isolated system) attended by an augmentation of the entropy are not only permissible, as the second law states, but one of them will necessarily take place spontaneously." Any one who has waited for a piece of graphite shut up in a box to turn into a diamond will realize that there is something the matter with this. On page 115, the phase rule states, not that no more than three phases can be simultaneously in equilibrium, but that if more than three phases are in equilibrium there is some special relation between their properties. On page 120 the melting and regelation of ice under skates is usually thought to be connected with the one-sided pressure in the ice under the runners, not the hydrostatic pressure. The depression of the melting point by one-sided pressure is roughly ten times greater than by hydrostatic pressure. On page 130 I think it is recognized that the arguments of Keesom and von Laue against the existence of transitions of the second kind are invalidated by considerations which Epstein does not suggest, because a crossing of the potential curves may correspond to negative masses on one side of the point of intersection and so be physically meaningless. It is highly probable that various order-disorder transitions in alloys are actual examples of

transitions of the "second kind." On page 159 there is an unqualified statement that a neutral atmosphere does not influence the vapor pressure. It is true that the effect is very small, but it is definite and may be deduced by thermodynamic methods, as in Lewis and Randall, page 183, first edition, for example. The treatment of work function and potential differences in the chapter on the electron and ion clouds I think is very confusing and in need of radical clarification. On page 267 it is made to appear that the potential used in the analysis is the classical electrostatic potential; in a footnote on page 274 it is explained that it is not the classical potential, but is derived from the force on the electron *under the actual conditions* (that is, it includes the image force) and then on page 275 the Volta contact potential difference is found by subtracting two of these, whereas the Volta difference by definition is the difference of the classical potentials. Later, on page 367, the same confusion leads to a completely unjustified relation between Volta difference and Peltier heat.

One can excuse these various defects, some of them copied from the literature, in view of the fact that the author has put into the book a number of results of his own independent investigations. His little investigation of the historical background of the first law and why it was first formulated by men outside physics will be found illuminating. There is a chapter on the le Chatelier principle which is much more carefully done than usual, and recognizes that really two different principles are involved. There is a final chapter on the limitations of thermodynamics reproduced from the author's contribution to the "Commentary on the Writings of Gibbs" recently issued by the Yale University Press. All in all, a most useful career may be anticipated for this book.

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HIGHER ALGEBRA

Modern Higher Algebra. By ADRIAN ALBERT. Chicago University Press, xiv + 319 pages, $4.00.

THE title of Professor Albert's "Modern Higher Algebra" is very apt. The book is "modern" in its organization of algebraic theory around such central abstract concepts as those of a group, a ring, an integral domain and a field. This organization was perhaps inspired by van der Waerden's now classic "Moderne Algebra," but has never before been done in an English or American text.

The book is also a "higher algebra," in that it deals with such relatively advanced topics as the classification of fields and matrices, the abstract extension of fields by adjunction of roots of polynomial equations, Galois theory, Galois fields and valued fields ("bewertete Korper"). The study of matrices goes beyond anything in van der Waerden, but ideal theory is not studied.

The exposition of these subjects is extremely clear in detail throughout. On the other hand, the abstract point of view will not easily be assimilated by the average college undergraduate, who will also be hampered by the absence of any treatment of such "elementary" things as complex numbers and determinants. The dabbler, too, will find it hard to detach morsels of intellectual nourishment from a complex and highly coherent mass of ratiocination.

But the serious student of mathematics will find Professor Albert's book stimulating and packed with ideas. It is in a class quite apart from the mediocre and nearly identical "college algebras" which American commercial publishers seem to prefer. The University of Chicago is to be congratulated for publishing an indispensable book, which every specialist in algebra should own.

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SPECIAL ARTICLES

DEVELOPMENT UNDER STERILE CONDITIONS OF THE SHEEP STOMACH WORM HAEMONCHUS CONTORTUS (NEMATODA)

IN a paper now in press we report the cultivation of bacteria-free larvae of *H. contortus,* in a suitable medium, up to the infective stage, *i.e.,* through the two larval free-living stages. The larvae obtained from such cultures differed from those grown under natural conditions in that they were slightly smaller, although the size ranges overlapped. These *Haemonchus* larvae produced in a susceptible lamb normal adult forms.

We wish here to report progress in the cultivation of the parasitic stages. At first we used for the inoculum the bacteria-free larvae from the cultures of the free-living stages. It was, however, difficult to secure enough larvae from the initial medium and we therefore used larvae that had reached the end of their free-living stage in sheep feces. These larvae were isolated in a Baermann funnel.

Since bacterial sterility appears to be an absolute requirement for further progress, the infective larvae were washed by sedimentation many times in sterile water in long glass tubes. To expedite the sterilization and also to unsheath the infective filariform larvae, Labarraque's solution, diluted one to twenty parts with distilled water, was also used. Unsheathing takes only about fifteen minutes, but the entire procedure includ-

ing the washings consumes about two and one half days. This not only removes the microorganisms adhering to the cuticle of the larvae but gives time for those within the larval intestine to be excreted and eliminated. The final washing is always made in Ringer's solution, after which the nematodes are transferred to a special medium. Being unsheathed infective forms, they are now in the stage in which they would normally continue development in the abomasum of the sheep.

The medium consisted of a 0.5 per cent. agar in Ringer's solution containing sheep liver extract, heat-killed ground yeast, sheep blood and sheep kidney, the last either in small pieces or as an extract. The reaction was adjusted to pH 3.0. Two or three drops of defibrinated sheep blood were added to the surface of the semi-solid medium prior to inoculation with several drops of the nematodes suspended in Ringer's solution. The cotton-plugged tubes after inoculation were sealed with sealing wax and incubated at a temperature of 39.5° C.

In numerous tubes examined at intervals during three weeks of incubation, definite development into the parasitic phase has been demonstrable. The presence of new sheaths enclosing the larvae, which were introduced unsheathed into the culture, is an early sign. There is little or no growth during this period, which ends with the ecdysis of the third larval (first parasitic) stage, shown by the presence of cast sheaths and live fourth larval (second parasitic) stages. With subsequent growth and differentiation, these fourth stage larvae have commonly reached a size of 1–2 mm; and some exceeding 3 mm in length have been found. The larger specimens show a well-defined provisional buccal capsule; esophagus 0.3–0.4 mm long; markedly elongated genital primordium, exceeding 200 μ, whose termini can not be easily determined; and clear-cut differentiation into males and females by characteristic configuration of the posterior ends. By comparison with the figures and descriptions of Veglia,[1] these larger forms are advancing into the last third of the fourth larval stage, and by his chronology are comparable to the sixth day of parasitic life in the abomasum. They are about five times the length of the unsheathed larvae with which the culture tubes were inoculated.

We have not seen adult worms in our cultures, but feel confident that these will be obtained with some further slight modifications of the nutritional environment. From the work to date, we do not believe, as has been occasionally concluded by other investigators, that a serious obstacle exists in culturing parasitic stages of the helminths of mammals. The successful *in vitro* culture of the parasitic worms should lead to a more adequate understanding of their physiology and to further elucidation of the mechanism of immunity developed against helminths by their hosts.

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[1] Frank Veglia, 3rd and 4th Reports Dir. Vet. Res. Onderstepoort, pp. 349–500, 1916.

EVIDENCE OF A ROTATIONAL GROWTH FACTOR IN BACILLUS MYCOIDES

IN recent years the question of spirality in animal and plant cells has received wide-spread attention. Little progress has been realized in obtaining an explanation of the phenomenon, but in general it would seem that spirality may arise from the cell itself and is due to the resolution of two growth factors, one longitudinal and one rotational. According to Smith[1] spontaneous growth movements have been said to be due to a wide variety of conditions such as osmotic currents, the action of cilia, peristaltic contractions, protoplasmic streaming and the secretion of gelatinous materials.

Rotation of cells on their long axis is not unknown among the *Thallophyta*. Smith mentions that many of the *Oscillatoria* exhibit such rotations, and Pringsheim and Langer[2] call attention to the well-known twisting in certain of the *Begiotta*.

Hastings[3] has suggested that the characteristic spirality of colonies of *Bacillus mycoids* may be comparable to the spirality in other single-celled organisms, in higher plants and animals. The efforts of numerous bacteriologists to explain the cause of colonial spirality constantly exhibited by *B. mycoides* have failed to produce a convincing explanation. Recently, while studying growing cultures, it was possible to confirm the observations of Pringsheim and Langer concerning the occurrence of spirally twisted filaments of *B. mycoides* (see figure). Evidence obtained from studies on such spiral twists indicates that *B. mycoides* possesses a rotational growth factor which may be responsible for the typical colonial spirality on solid culture media.

A possible explanation for the formation of the rarely occurring spiral twists was sought. Two explanations seemed possible: Either (1) in its normal forward growth the filament of cells moved through the proper planes to eventually form the spiral figure, or (2) the twisted spirals resulted from tension produced by rotation of the cells on their long axes when at some point the filament was so firmly attached that the only relief was to twist or break.

Two methods of establishing conditions under which spiral twists form in great numbers have been successful. In both methods the conditions produced were

[1] G. M. Smith, "The Fresh Water Algae of the United States," McGraw-Hill Book Co., New York, 1933.

[2] E. T. Pringsheim and J. Langer, *Centbl. Bakt.* (etc.) II Ab., 61: 225, 1924.

[3] E. G. Hastings, SCIENCE, 75: 16, 1932.

such that one end of the chain of cells was firmly attached, while the other end was free to move about in a liquid menstruum. The spiral twisting was so rapid that it could be directly observed. It seems that the success in producing twisting filaments under these conditions strengthens the assumption that they form when under stress produced by rotational growth.

Spores of *B. mycoides* were heavily seeded into tubes of liquid 2 per cent. nutrient agar, and thin smears were made from the seeded agar on sterile glass slides resting within petri plates. After solidification of the film of agar, nutrient broth was poured into the petri plate to a depth just sufficient to completely cover the slide and smear. After 24 hours' incubation, the spores had germinated and the tendrils of cells had grown out into the nutrient broth. Spirally twisted loops were present in great numbers. This method of producing subjects for study has the disadvantage of rendering impossible examination with the oil immersion objective, since the slides must be examined while submerged.

A second procedure gave specimens more suitable for close examination. Plates of 2 per cent. nutrient agar were spot inoculated and a colony of two to three centimeters in diameter was allowed to develop. A small rectangular section of the agar, taken near the edge of the growing colony, was transferred to a glass

FIG. 1

slide and a cover slip was pressed tightly down upon the growing cells. The cover glass was sealed to the slide by generous amounts of vaseline, and nutrient broth was injected under the cover slip into the space between the agar block and the vaseline seal. After one to two hours the chains of cells had grown out into the broth and at the intersection of the agar with the broth, spiral twists could be observed forming. The subsequent observations herein reported were made on subjects prepared in this manner.

It was not possible to observe rotational growth by direct microscopic examination of the filament of growing cells. Neither has it been possible to facilitate direct observations of rotational growth by the attachment of particles of silica, charcoal or kaolin to the bacterial cells. It has been possible to determine the direction of rotation of the loop within spirally twisting filaments. Loop rotation is a direct function of the filament rotation. Account was taken of the inverted image given by the compound microscope.

Hundreds of loops of both left (counter clock-wise) and right (clock-wise) spiral strains of *B. mycoides* have been studied and, without exception, loops of left spiral strains rotate from left to right (loop away from the observer, ends of the filament toward the observer), and of right spiral strains from right to left.

The production of new cells in filaments of *B. mycoides* occurs most profusely at the end of the filament. Hence, it is probable that any rotational growth would be most pronounced in the young developing cells which are farthest removed from the attached end of the filament. If this is true, a loop rotation (loop away from observer, ends of the filament toward observer) from left to right would indicate a filament rotation from right to left, when the growing tip is away from the observer and the attached end of the filament is toward the observer. Likewise, a loop rotation from right to left would indicate a filament rotation from left to right under the same condition.

Since left spiral strains invariably give loop rotation (loop away from observer) from left to right, it seems probable that the filament rotation (growing tip away from observer) from right to left is responsible for the left-hand (counter clock-wise) spirals produced by these strains on solid culture media. With the right spiral strains, a filament rotation from left to right is probably responsible for the production of right spiral colonies.

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CARCINOGENICS AND GROWTH STIMULATION[1]

ALL stimulants to growth do not result in cancer, but it seems apparent, as Loeb *et al.*[2] have said, "all causes of cancer directly or indirectly stimulate growth." Goldstein[3] has suggested acceleration of bacterial reproduction as a microbiological test for carcinogenic hydrocarbons. Hammett and Reimann[4] have shown that methyl cholanthrene, a carcinogenic, enhances the production of new growth from anlagen in *Obelia geniculata*. The same authors[5] found proliferation activity of Obelia to be stimulated by the carcinogenic 1:2:5:6 dibenzanthracene.

Our studies, employing planaria (*Euplanaria dorotocephala*) show 1:2:5:6 dibenzanthracene to stimulate both regeneration of cut segments and reproduction of whole animals. In a test period of over a

[1] Published with the permission of the Medical Director of the Veterans' Administration who assumes no responsibility for the opinions expressed or the conclusions drawn by the authors.

[2] L. Loeb, E. L. Burns, V. Suntzeff and M. Moskop, *Am. Jour. Cancer*, 30: 47–53, 1937.

[3] S. Goldstein, SCIENCE, 86: 176–177, 1937.

[4] F. S. Hammett and S. P. Reimann, *Am. Jour. Cancer*, 25: 807–808, 1935.

[5] S. P. Reimann and F. S. Hammett, *Am. Jour. Cancer*, 23: 343–349, 1935.

month there were approximately 45 per cent. more animals in the test than in the control jars. With triphenyl benzene, whose carcinogenic activity has been recently questioned, the whole animals were similarly stimulated while the segments failed to react.

With glutathione, a known tissue growth stimulant, the results were similar to those obtained with dibenzanthracene. Derivatives of glutathione, as glutamic acid, glycine and cysteine, produced no evident stimulation of growth in the segments or increase in the number of planaria.

Allantoin and preserved larval extract did not stimulate growth or reproduction of the cut or uncut animals.

Complete details of the technique, histology of the treated specimens and further results will be presented when the study is completed.

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THE EFFECT OF FAST NEUTRONS ON DRY SEEDS

THE experiments discussed in this paper had a twofold purpose: (a) to determine whether dry seeds left on the outside of the cyclotron "tank" would receive enough stray neutrons to produce a cumulative harmful effect preventing their subsequent germination; and (b) to determine whether changes in external morphology, similar to those produced by x-rays,[1, 2] radium and radium salts, would occur in plants grown from the neutron-bombarded seeds.

Plants with very small seeds were chosen for these experiments in order that a large number might be used at one time in the limited space available for bombardment by the cyclotron.

Seeds from each of the selected species and varieties were put into small (2.3 × 0.8 cm) gelatin, medical capsules which proved to be most satisfactory for handling the tiny seeds. More than 500 seeds of the oenotheras, for example, were placed in a single capsule without crowding.

The capsules were in turn placed in a small (8 × 8 × 6 cm) lead box whose 1 cm. thick walls were lined inside with a 2 mm layer of paraffin. The purpose of the lead was to filter out all emanations from the cyclotron except the neutrons, and that of the paraffin to increase the effect of the neutron bombardment within the seeds. A lead cover 1 cm thick was anchored to the box after the capsules bearing the seeds had been placed within.

The whole was then laid on a small metal shelf attached to the outside of the cyclotron "tank" so as to be close to the bombarding chamber, but at a distance of about 60 cm from the target. In this way the seeds could absorb only stray emanations from the cyclotron, whenever it was in operation, during the three months in which these experiments were conducted.

Seeds of the various kinds were removed from the capsules from time to time and put on wet filter paper in Petri dishes to obtain germination counts. Then the germinating seeds were planted in soil in order to obtain seedlings and mature plants upon which to observe possible morphological changes due to the neutron bombardment.

All exposures were made on the University of Michigan cyclotron through the cooperation of Professor J. M. Cork and Dr. R. L. Thornton, of the physics department.

Normal germination for all plants used in these experiments is above 90 per cent.

Table 1 shows three things: (a) that as exposure time increases the percentage of germination in some plants decreases, whereas (b) in others there is little or no appreciable effect, and (c) that there is a wide range of susceptibility to neutrons as has already been found for a large number of x-rayed plants by Johnson.

TABLE 1

Species studied	Weeks subjected to emanations	Percentage germination
Oenothera franciscana	1	95.0
Oenothera franciscana	2	82.5
Oenothera franciscana	9	15.4
Oenothera blandina	2	94.8
Oenothera blandina	9	51.9
Echinocereus papillosus	1	16.8
Rhipsalis rhombea	2	29.2
Neomammillaria multiceps ..	2	99.5
Antirrhinum sp. (1)	6	5.0
Antirrhinum sp. (2)	6	75.0
Antirrhinum sp. (3)	6	23.0
Myosotis sp.	6	18.7

The morphological variations in the plants grown from treated dry seeds were numerous, and it is noteworthy that often they are found to be similar in more than one species. This same phenomenon occurs in x-rayed plants. A brief summary of the variations and their relative frequencies are discussed in the following paragraphs.

A condition which was observed to be most common was the decrease in size of plants grown from rayed seeds as compared with normal plants. They were not only shorter, but the stems and leaves were smaller and weaker.

In *Antirrhinum* the cotyledons were invariably found to be covered with numerous white dots or

[1] J. H. Lawrence and E. O. Lawrence, *Proc. Nat. Acad. Sci.*, 22(2): 124–133, 1936.

[2] R. E. Zirkle and P. C. Aebersold, *Proc. Nat. Acad. Sci.*, 22(2): 134–138, 1936.

patches. Leaves having white dots or patches were evident in all species studied, with the exception of the cacti. One plant of *Antirrhinum* showed a remarkable condition in its cotyledons in that a white band about 5 mm wide crossed each cotyledon in exactly the same place.

In *Myosotis,* deeply cleft cotyledons occurred in about one fifth of the seedlings. This condition was not observed in any of the other species studied.

Leaves which were slightly notched or deeply cleft were observed frequently in *Myosotis* and *Antirrhinum,* but only twice in *Oenothera franciscana*—no variation of any kind being observed in *Oenothera blandina.* Each of the two parts of a leaf resulting from a deep cleft often showed a separate, well-developed midvein.

In a large number of cases a considerable part of a leaf was deleted so that there was no tissue on one side of the midrib, only a small irregular mass with or without veinlets going into it from the midrib; or the leaf was perfectly normal except for a small deleted area. A number of rather twisted and grotesque forms resulted from the radiations.

In summary, the bombardment of dry seeds of certain species by stray neutrons had no effect on germination, whereas in other species it caused a decrease in germination directly proportional to the duration of exposure. Seedlings and mature plants grown from the neutron-bombarded dry seeds showed a number of morphological variations from the normal condition.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE SEPARATION OF PLANT VIRUSES BY CHEMICAL INACTIVATION[1]

SOME virus complexes, which may occur in nature or in accidental mixtures in experimental work, are often difficult to separate by known or convenient means. An investigation of the possibility of the use of chemicals for this purpose was therefore undertaken, with the expectation that some additional light might be thrown on the nature of the viruses themselves by their reaction toward chemical substances.

The separation of certain combined viruses has been accomplished by treatment of the plant extracts containing the viruses with chemicals which have proved to be specific inactivators for certain viruses. Water solutions of the chemicals were added to the extracts and allowed to act at 20° C. for one hour. These preparations were then diluted to one part in fifty parts of water in order to reduce any possible chemical injury when inoculated to the host (*Nicotiana tabacum* Havana variety). If symptoms caused by only one virus were apparent, extracts from such plants were tested for purity by further inoculations to Havana tobacco. Repeated trials were made with such chemicals as showed promise, and a wide variety of chemicals in various concentrations have been tested.

The separation of a mixture of the viruses of cucumber mosaic and potato ring spot may serve for illustration in this preliminary note. Tests were made to determine the minimum concentrations of chemicals necessary to inactivate each of these viruses, and it was found that cucumber mosaic virus could withstand higher concentrations of silver nitrate and mercuric chloride than could the potato ring spot virus. Conversely, it was found that the potato ring spot virus could withstand higher concentrations of potassium permanganate, lithium carbonate and copper sulfate. Mixtures of these two viruses were treated with concentrations of potassium permanganate ranging from 0.1 to 0.9 per cent. in ten separate experiments, and only the potato ring spot virus remained infective, except in one trial where both viruses were inactivated by the same concentration of the chemical. In three trials 1 per cent. lithium carbonate and 2 per cent. copper sulfate gave similar results. However, using the same extracts as above the potato ring spot virus could be inactivated, leaving the cucumber mosaic virus infective. This result was secured in four trials by treatment with silver nitrate ranging in concentration from 0.1 per cent. to 0.5 per cent., and eleven times by treatment with 0.1 per cent. to 0.9 per cent. mercuric chloride in as many trials. The exact chemical concentrations necessary for a definite separation can not always be accurately determined since fairly wide variations in behavior have been observed.

The reasons for the differential action of the chemicals used are obscure. In preliminary determinations, hydrogen-ion concentration did not seem to be correlated with the inactivation of the viruses in these experiments.

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[1] Supported by Wisconsin Alumni Research Foundation.

A METHOD FOR FINDING THE FREE WATER IN PLANT TISSUE

ABOUT a month ago I was approached by the scientists at the Northern Rocky Mountain Forest Experi-

mentation Station, who wanted to know if I could suggest a method whereby the amount of free water in samples of forest vegetation could be determined with reasonable accuracy. It occurred to me that by determining the heat capacity of a sample of a plant tissue, then driving off the moisture and then redetermining the heat capacity, a measure of the amount of free water, which has a specific heat of approximately one calorie per gram per degree Centigrade, could easily be obtained.

A sample experiment convinced me that the method could be used to good advantage. For my test experiment, I selected a sample of potato tissue, and in order not to destroy any of the cell structure in the process, I cooled the sample to a temperature near the freezing point of water, then placed it in a calorimeter, the water content of which had a temperature slightly above that of the room and thus determined from the temperature fall of the water the heat capacity of my weighed sample of potato tissue.

After two days and nights of gentle drying on a moderately warm radiator, I determined the heat capacity of the dry residue, subtracting this heat capacity, which was quite small, from the original heat capacity. I found that the water originally in the potato had in that state an average specific heat of .70 calories per gram per degree, indicating that only a part of this water could have been present in the form of free water. The rest must then have been present in a chemically bound form.

Since the determination of free water in plant tissue is a somewhat cumbersome process, and at times yields dubious results due to the effects of maceration, I hope this description of a calorimetric method will be found useful by horticulturists, plant pathologists and others.

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AN IMPROVED TISSUE CULTURE CHAMBER[1]

THE observation of tissue cultures, made in the hanging drop on a cover glass, is often difficult because of the excessive and uncontrollable thickness of the drop, and also because of the curvature of its free surface. In addition, the spherical surface of the depression in the slide increases the optical difficulties. Although there are on the market hollow slides with a plane-parallel bottom of the chamber, all of them are so thick that even the employment of a long focused condenser can not render proper illumination.

To correct these imperfections, a chamber was devised which consists primarily of an ordinary slide, about 0.75 mm thick, with a round hole of about 1.5 cm in diameter, drilled through its center. This hole is bridged over by a cover glass which is cemented to the lower surface of the slide along the edge of the hole, thus forming a shallow container with a plane and thin bottom (Fig. 1) which obviates the optical difficulties mentioned above.

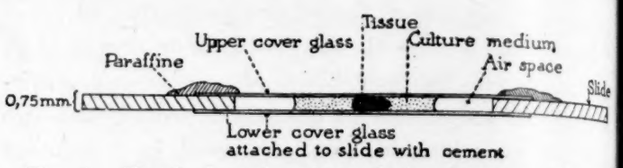

FIG. 1. Vertical section through the chamber. Note the plane-parallel surfaces of the chamber and the even thickness of the culture medium.

In preparing the tissue culture, one places the drop of the medium and the tissue particle in the center of the chamber so that the peak of the drop reaches slightly above the level of the upper surface of the slide; then the drop flattens out to a plane-parallel layer between the two cover slips. Care must be taken that the drop does not fill the entire chamber so that enough air space is left for the respiration of the tissue. The upper cover glass is sealed with paraffin in the usual manner.

The advantages of this chamber are: simplicity of construction, use of standard material (ordinary slide and cover glass), easy replacement of bottom when broken, elimination of surfaces causing optical disturbance and close proximity of culture to condensor.

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